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Biotic Sleuth

A new breed of insect fighter is emerging on the agricultural scene. He is the scientist concerned with the bioenvironmental control of insect pests, a seeker and exploiter of vulnerable strands in the tangled web of interdependence of living things and their environment. In the language of science, his lab is an ecosystem such as an orchard or corn field; the object of his inquiry, the biota or plant and animal life dwelling therein. His varied arsenal of weapons largely involves manipulating the biota of an ecosystem.

Nature, with her checks and balances, is the ultimate model for controlling pests bioenvironmentally. She generally succeeds remarkably well but her control, unfortunately, usually comes too late to save a beleaguered crop. To direct and speed nature's control processes, scientists first build a body of knowledge about a pest—its life history, metabolism, habitat, reproduction, and much more. They also probe the ecological relationships between the pest and the crop it attacks, the pest and its natural enemies.

Armed with this knowledge, scientists can attack vulnerable points in the pest's life cycle to create food shortages, cause exposure to adverse weather, tilt the balance in favor of natural enemies, or otherwise force the pest out of step with nature. A key weapon is the use of biotic agents: predators, parasites, pathogens. Those existing in a field are a vital resource for suppressing or managing pests. Scientists are learning how to create favorable environments for the survival of the agent and, if necessary, when to periodically release mass-reared reinforcements. Timing can be delicate, especially in selecting proper weather conditions and in synchronizing the life cycles of biotic agent and pest.

There are other bioenvironmental manipulations. They include changes in plowing, planting, irrigation and other farm practices to either adversely change the pest's environment or improve that of its natural enemies. Properly planned and executed, these manipulations can strongly influence the availability of food, reproductive territory, and protective cover. Plowing, for example, can destroy certain insects during the soil-inhabiting periods of their life cycles. Plant spacing can curb pest numbers by changing their microhabitat and the density of their food supply.

Bioenvironmental control even in its infancy, holds promise of fully controlling certain pests. In other cases it will significantly augment a growing array of sophisticated techniques to aid man in his incessant war on insects.

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COVER: Machine harvested lettuce is in the offing. ARS researchers at Salinas, California, have developed this crisphead lettuce harvester toward the goal of reducing harvesting cost and helping growers meet booming consumer demand for lettuce (0973X1444-25). See story on page 8.

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Technician Ray Olek examines a Sundak sunflower head (0973X1450-15).



A bright future for hybrid sunflowers

A SEVERE OUTBREAK of downy mildew in 1970 gave warning that the otherwise bright future for sunflower production in the Red River Valley of the North was in jeopardy. All commercial varieties were susceptible to the seedborne and persistent soilborne disease.

ARS scientists at Fargo, N. Dak., and College Station, Tex., in cooperation with the North Dakota Agricultural Experiment Station, began an accelerated research effort that culminated in the release of breeding lines needed for production of high-yielding oilseed sunflower hybrids resistant to downy mildew.

Introduction of rust-tolerant, high-oil Russian varieties in 1966 opened the way for the establishment of sunflowers as an important crop in North Dakota and Minnesota. Production there expanded rapidly, with some 800,000 acres of land planted to oilseed and confectionery varieties of sunflowers by 1972.

Confectionery varieties, which make up about a quarter of the acreage, are as susceptible to downy mildew as the oilseed varieties, but much more susceptible to sunflower rust, a disease that lowers yield as much as 50 percent in some confectionery fields, and adversely affects seed quality. The threat of rust will be minimized when seed of the new confectionery variety Sundak becomes generally available. A cooperative development of ARS and North Dakota research, Sundak is a confectionery variety highly resistant to predominant races of rust in the Red River Valley.

Development of oilseed sunflower hybrids resistant to downy mildew was based on a series of research advances by ARS and foreign scientists. Commercial production of sunflower hybrids was made feasible by two discoveries—cytoplasmic male sterility in the sunflower by a French scientist and the gene for fertility restoration by ARS agronomist Murrery L. Kinman,

College Station, (AGR. RES., June, 1971, p. 3).

Between 1966 and 1971, Romanian and French scientists reported isolation of mildew resistance in four inbred breeding lines. In 1969 field trials in Texas and Minnesota, Dr. Kinman determined that one of these, HA 61, carries a dominant gene or genes for downy mildew resistance.

In 1970, ARS plant pathologist David E. Zimmer, Fargo, evaluated a wide range of inbred lines, experimental hybrids, and varieties from both domestic and foreign sources for resistance to downy mildew. The inoculum used was collected from mildew-infested sunflowers in the Red River Valley.

Only HA 61 and two sister lines proved resistant. Significantly, the other three lines reported to be resistant in Romania and France were susceptible in the North Dakota and Minnesota tests. This finding for the first time indicated existence of distinct

pathogenic races of *Plasmopara halstedii*.

Dr. Zimmer and Dr. Kinman subsequently established the existence of a single dominant gene that conditions resistance to the Red River Valley race of downy mildew in HA 61. Thus, incorporation of this gene into one parent would produce resistance in hybrids, even though the other parent is susceptible.

A coordinated program of simultaneous testing and seed increase resulted in development of RHA 271, RHA ND273, and RHA ND274, downy mildew-resistant restorer lines for crossing with cytoplasmic male-sterile lines to produce high-yielding resistant hybrids. These fertility restorer lines, released last spring, have an added advantage of producing pollen over a longer than normal period. Failure of male and female lines to flower simultaneously has been a persistent problem in hybrid sunflower produc-

tion.

Meanwhile, development of Sundak, a large-seeded confectionery variety resistant to rust, began in 1970 with the discovery of a few rust-resistant plants in a severely rusted field of the Commander variety. Dr. Zimmer and ARS plant geneticist Gerhardt N. Fick produced progenies from 22 of these plants, inbred them for two generations, and selected for rust resistance. Seed from 98 resistant plants were produced in Hawaii in the winter of 1971-72, evaluated for yield, and grown for seed increase in North Dakota last summer.

Both rust-resistant Sundak and mildew-resistant oilseed hybrids produced with RHA 271, RHA ND273, or RHA ND274 as the male parent should be commercially available for 1974 planting. Cultivation of these varieties will reduce yield losses from rust and downy mildew and significantly increase the acceptance of sunflowers as a cash crop in the Red River Valley. □



Left: Mr. Olek in a field of wild sunflowers which supply germ plasm for disease resistance in the Fargo breeding program (0973X1452-10). **Above:** Dr. Zimmerman reads strip chart showing oil content as determined by nuclear magnetic resonance analyzer. Oil content is one of the vital characteristics in breeding hybrid oil-type sunflowers (0973X1451-1).

Seed sorcery

SEEDS are being shocked, bounced, blown, squeezed, sieved, and made to act like a liquid in order to develop better means of separating and handling them.

Seeds are the basis of agriculture, the world's largest single industry. The annual value of U.S. crops grown for seed alone tops \$750 million. Not only are seeds important as food and feed, but they are also a source of basic raw material for many manufacturing processes, besides their use as planting stock.

As it comes from the field, seed is often contaminated with other crop seeds and weed seeds. Handling and cleaning seeds to meet required quality standards with today's available techniques may result in losing up to 50 percent of the good seed.

In order to save more of this good seed, agricultural engineers Joseph K. Park, N. Robert Brandenburg, and Leonard M. Klein, have devised and tested some unique cleaning techniques—all of them based on a simple premise: different seeds have different properties. Each variety has its own size, shape, weight, density, color, resilience, and other physical and chemical properties. Machines can be designed to exploit these differences.

The most widely used commercial machine is the air-screen unit. All other separators can be considered secondary to air-screens in the cleaning operation. Air-screens clean or separate seeds on the basis of size, shape, and density.

Seed is introduced into an air stream which removes light, chaffy material; remaining seed is distributed over a perforated top screen. Seeds conforming to the required dimensions will pass

through the screen, while larger, unwanted material or seeds will not, and will be removed.

Different-sized screens may be stacked so that several seed gradings can be made. Screen holes may be round, slotted or a combination of the two, as needs require.

After air-screening, further separations are often desired. ARS researchers are testing techniques employing different principles and different procedures to do the job.

Velvet roll separators, for example, utilize seed surface texture and shape. Seeds are fed onto a pair of velvet-covered rolls that are set at an angle. As the rollers rotate outwardly in opposite directions, rough, sharp pointed, and broken seeds catch in the velvet and are thrown against a shield which deflects the seed into storage pans beneath the rollers. Smooth-coated seeds spin down the incline and are discharged from the lower end of the rollers in a graduated manner, the smoother the seed the farther it travels.

An experimental vibrator separator also utilizes surface texture and shape. Seeds are centered on the upper edge of an inclined, solid-surfaced, reciprocating deck. The deck's vibrations cause the seeds to climb the incline, but flat, rough, or hairy seeds climb more readily than rounded or smooth seeds. Eventually the smoother, rounder seeds are discharged off the lower edge of the tilted deck, while the rougher seeds migrate to the raised end. Vibrators can make separations too difficult or impossible for screen separators to make.

Because some seeds retain an electrical charge longer than others, electrostatic seed cleaners may one day be used as separators. Seeds are placed on

a conveyor belt and passed through an electric field where they become charged. A charged seed clings to the underside of the conveyor belt, moving along until it loses its charge and drops off. Dividers and containers positioned in the drop path beneath the belt collect the seed.

A resilience separator can be used for seeds that bounce more than other seeds. Consisting of a long inclined plane interrupted with several bounce plates, seeds slide down the plane and impact on the first plate. Seeds that bounce farthest from the plane are trapped while others continue down the plane to another plate. Good bouncers get several chances to be trapped while poor bouncers end up at the bottom of the plane.

Once seeds are harvested they must be handled many times in receiving, drying, cleaning, and bagging. Presently used mechanical contrivances often are too slow and damage seed. Improvements may come from two methods under study by the ARS team: pneumatic conveyors and fluidization. Pneumatic systems transport materials through conveying pipes using a column of air. This can be done with a vacuum system, or a low, medium, or high pressure system.

In fluidization, air is passed through a porous membrane material into a seed container. The seed mass expands and acts much like a liquid. The upper surface becomes level, air bubbles burst through with the turbulence of boiling water, and solid objects, like a golf ball, will sink instead of setting on the surface.

Fluidized conveying offers the advantages of good clean out, flexible vertical and horizontal movement, and mechanical simplicity. Also, seed can be moved at low velocities with a high seed-to-air ratio, suffering little damage. Other experimental cleaning and handling techniques are being tested. As long as there are seeds to be cleaned, the need for better separators and more efficient techniques to handle and ever increasing demand will continue. □



This V-notch weir is located at the outlet of one of the watersheds near Treynor, Iowa. All runoff leaves the watershed at the weir. During storm periods, samples are collected at weir sites until the flow becomes too deep (PN-2845).

Erosion control saves soil nutrients

WHAT is the most practical first step in eliminating fertilizer nitrogen and phosphorous as pollutants in surface runoff?

Do an effective job of controlling soil erosion.

The effectiveness of erosion control in minimizing stream pollution has been demonstrated. In a 3-year study on adjacent watersheds near Treynor, Iowa without erosion control, a large part of the nitrogen and phosphorous lost in runoff from agricultural land is carried by particles of eroded soil. When corn was fertilized at $2\frac{1}{2}$ times the recommended rate, only one-thirteenth as much nitrogen and one-ninth as much phosphorous was lost in runoff when erosion was effectively restricted as when it was not.

The study was conducted by soil scientists Gerald E. Schuman, Lincoln, Nebr., and Robert E. Burwell, Council

Bluffs, Iowa, agricultural engineer Ralph G. Spomer, Council Bluffs, and hydraulic engineer Robert F. Piest, Columbia, Mo., in cooperation with the Nebraska and Iowa Agricultural Experiment Stations.

The researchers monitored runoff and sediment yield of four watersheds and collected runoff samples for nitrogen and phosphorous analyses. Corn was grown on three watersheds—two farmed on the contour, one protected by level terraces. The fourth watershed was in brome grass pasture. Fertilizer was applied at the recommended rates, 150 pounds of nitrogen and 35 pounds of phosphorous per acre, on the grass and one contour-farmed watershed; $2\frac{1}{2}$ times these rates was applied on the other contour-farmed watershed and the terraced watershed.

Terracing proved markedly more effective than contour farming in re-

stricting runoff and soil erosion. Although the watersheds differed in size and other characteristics, the researchers found that the 83- and 74-acre contoured watersheds averaged, respectively, 7 and 9 times the average surface runoff and 12.5 and 19 times the average sediment loss of the 150-acre terraced watershed. The 107-acre grassed watershed had more surface runoff but less soil erosion than the terraced watershed.

Average annual loss of nitrogen in all forms was 28.8 pounds per acre with contouring, 2.7 pounds with terracing, and 2.1 pounds with grass. Significantly, 92 percent of the total nitrogen loss from contour-farmed watersheds and 86 percent from the terraced watershed was associated with sediment.

The high fertilization rate produced greater—though not proportionately greater—nitrogen loss than the recom-

mended rate on contour-farmed watersheds. With differences in runoff and sediment from the two watersheds taken into account, nitrogen loss in runoff was 40 and 21 percent greater in nitrate and ammonium forms, respectively, with fertilization at $2\frac{1}{2}$ times the recommended rate. Loss of nitrogen associated with sediment was only 4 percent higher.

A critical period for runoff and erosion, and consequently for nutrient losses, was during seedbed preparation and establishment of the crop. The pre-cropping period was also critical for soluble nitrogen losses because surface runoff is substantial when the soil is frozen.

Differences in phosphorous losses from the four watersheds were similar to those for nitrogen. Again, practices that minimized erosion also restricted movement of phosphorous from the land. Phosphorous is relatively immobile in soil, and most of that removed is adsorbed to eroded soil transported by runoff.

At the high fertilization rate, total phosphorous removal from the terraced watershed was only one-ninth that from the contour-cropped watershed. Losses of phosphorous associated with the sediment averaged 0.94 pounds per acre for contour cropping, high fertilizer rate; 0.52 for contour cropping, recommended rate; 0.08 for terracing, high rate; and 0.06 for pasture, recommended rate. Proportionately more of the phosphorous moved in inorganic form in solution, rather than with the sediment, when terraces or grass limited soil erosion.

The researchers found the phosphorous in solution adsorbed to sediment and probably to the raw, exposed gully floor and walls as runoff moved from gully heads to weirs located at watershed outlets. By the time runoff reached a main body of water miles from the watershed, a large proportion of the phosphorous was adsorbed by the suspended material and exposed edges of the channel. □

Explosion puffed potatoes: quick cooking and good

THE UNDESIRABLE off-flavor of explosion-puffed potatoes can now be overcome by a simple process modification.

Explosion puffing has so far been used commercially only to a limited extent, and then only on carrots. It has been applied successfully in the pilot plant, however, not only to potatoes but many other vegetables and fruits, including beets, peppers, celery, apples, and blueberries. The process makes products that cook in 5 or 6 minutes instead of the half-hour or more required for conventionally dehydrated foods (AGR. RES., Apr. 1964, p. 3; Oct. 1964, p. 7; Oct. 1966, p. 15; Apr. 1971, p. 14).

To make explosion-puffed products, pieces of the fruit or vegetable are air dried. Then before the drying is complete, they are exposed to super-heated steam in the revolving barrel of a puffing gun. Explosion from the gun forms tiny channels in the pieces as some of their moisture is suddenly vaporized. Through these pores the remaining water is readily driven out in a final drying step. When the product is reconstituted water is readily absorbed through these pores which accounts for the faster cooking time.

Potatoes are an attractive candidate for explosion puffing. Available the year round, they are widely used in prepared foods, such as soups and stews, where quick cooking is a special advantage. The difficulty is that in the explosion puffing of some potatoes, a browning reaction takes place between their sugars and proteins, one that produces off-flavors and odors. □

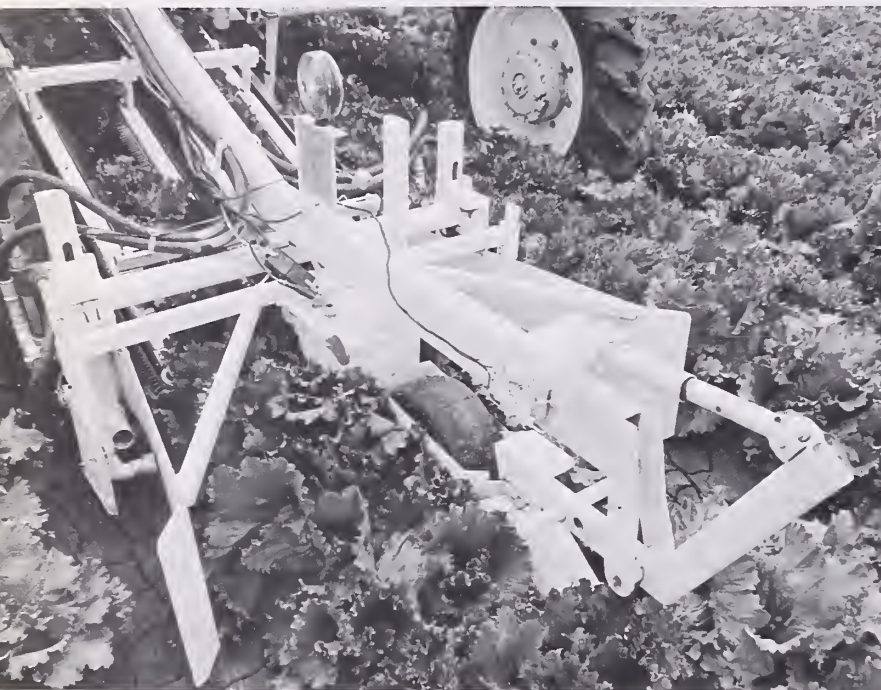
Experiments conducted by James Cording, Jr., John F. Sullivan, and other chemical engineers at the ARS Eastern Regional Research Center in Philadelphia, Pa., where the process was developed, showed that most of these browning off-flavors originate in the puffing gun.

Since carbon dioxide is one of the products of the browning reaction, the engineers thought development of off-flavors might be retarded if the gas was used to replace some of the steam in the gun. This approach worked, not only with carbon dioxide, but also with nitrogen and air.

The engineers found they could replace about a third of the steam with carbon dioxide or nitrogen and still puff the product satisfactorily for quick-cooking properties. They made potato dice with a 2:1 ratio of steam to nitrogen to see if this would control the off-flavor. These experimental dice, along with dice explosion-puffed with steam only, were reconstituted by cooking in boiling water. Vapors given off during cooking were trapped and analyzed for aldehydes, the substances responsible for the off-flavors and odors.

Subsequent taste-panel tests indicated that dehydrated potato pieces with good flavor could be made by the explosion-puffing process by employing steam-nitrogen mixture. Trained taste panelists liked all the samples puffed in this way, including some made from potatoes with high sugar contents which ordinarily would be especially susceptible to the browning reaction. □

Below: X-ray lettuce head selector in operating position. The X-ray unit is located directly behind the wheel (0973X1442-23).



HARVESTING LETT

Frontal view of the experimental lettuce harvester. For research purposes the machine is operated with a single head. Weights on the right compensate for the "missing" part. In commercial use, the machine would employ two heads, thereby harvesting two beds on each swath (0973X1443-12).



AN EXPERIMENTAL mechanical crisp-head lettuce harvester now under development may bring consumers twin benefits: more standard-sized lettuce heads and lower salad costs.

An expanding domestic and foreign market for lettuce—U.S. consumption from 1940 to 1970 increased from 13 pounds to almost 23 pounds per person—calls for low-cost production. The mechanical lettuce harvester may be the key element of a system that will enable producers to keep pace with market demand.

While mechanical lettuce harvesters have been under study for years, suc-

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Center: Heart of the harvester is the small medical type X-ray unit (right), shown here in close-up. X-rays transmitted through a mature head of lettuce trigger a mechanism that slices that head and starts it through the machine (0973X1444-29). Left: Held gently by an endless belt of hundreds of rubber fingers, lettuce heads move along toward a knurled disc that will trim off the bottoms, an operation formerly done by hand (0973X1444-31).

TUCE ELECTRONICALLY

cessful mechanization awaited the development of a selector to accurately and consistently determine head maturity.

A head maturity selector is necessary because lettuce crops mature irregularly so that hand pickers or mechanical harvesters must pass over the field from one to three times. A uniformly maturing lettuce variety will eventually give rise to once-over mechanical harvesting. Meantime, agricultural engineers must work with present varieties.

The key component of the ARS experimental harvester is an X-ray lettuce head selector (AGR. RES., Mar. 1971, p. 14) developed at Salinas, Calif., by

agricultural engineers Paul A. Adrian, Don H. Lenker, and technician Dennis Nascimento. A mechanical selector is also adaptable to the machine. Both the X-ray and mechanical selectors were evaluated in recent tests. Mechanical selectors have been developed by the Universities of Arizona and California; the latter has also developed a gamma ray selector.

A comparative study of the four selectors showed the ARS X-ray and University of California gamma ray selectors to have an edge over mechanical selectors and to equal or surpass hand selection.

In selecting lettuce by X-ray, the

heads pass between a small inexpensive medical type X-ray unit and a photodiode shielded from light. The amount of X-rays transmitted through the head—sort of an “electronic squeeze”—is detected by the photodiode. The amount of rays reaching the photodiode is governed by the diameter and density of the head. When mature heads pass between the units, a signal activates a knife that slices off the head and starts it through the machine.

Mechanical selectors operate by springs. If a head of lettuce is solid enough to spread spring-loaded rollers apart a certain distance, a microswitch activates a knife and that head begins

its mechanized trip to the salad bowl.

Once on its way, the lettuce head is gently held in position by a rubber-fingered endless belt which passes it over a knurled disc that lops off the bottom of the head, an operation formerly performed by hand.

The trimmed heads are next lifted atop the machine into an accumulator. By slightly tilting the accumulator and employing vibration, the lettuce heads are fed through two foam rubber rollers that evenly space them on a moving belt which passes workers who trim and pack the heads 24 to a carton, ready for shipment.

A four-row, two-bed machine employs a 15-man crew: an operator-driver, four trimmers, eight packers, and two carton closers. The carton closers, however, follow the machine, doing their work on the ground.

Under ideal conditions, the experimental harvester operates at 2 miles per hour, harvesting two beds—four rows—of lettuce. It covers 1½ acres per hour at 75 percent field efficiency, which means that for 25 percent of the time the machine is turning at the end rows or is otherwise “down” part of the time.

Test results show that in lettuce fields yielding about 7,200 heads per acre per cutting, the machine can harvest about 450 cartons per hour (24 heads per carton). The machine’s capabilities according to other yields are: 9,600 heads, 600 cartons; 12,000 heads, 750 cartons; and 14,400 heads, 900 cartons. These figures indicate machine capability and do not reflect manpower bottlenecks.

Realistically, however, the machine is limited by the rate at which the crew can trim and pack. Under ideal conditions with a good, trained 15-man crew, a harvest of 400 cartons per hour can be expected.

Fifteen men harvesting lettuce by

hand can pick, trim, and pack 12 to 15 cartons per man per hour. With a 15-man crew, that comes to 180 to 225 cartons per hour.

Two systems are being considered to increase the efficiency of the machine, hopefully at least doubling its harvesting capacity. They are:

- Conveying harvested lettuce into a companion bulk trailer to transport to a centralized location—at the field edge or packing shed—for quality inspection and packaging. This has the advantage of not tying the workers to the machine. The harvester and workers would both perform at full capacity due to a more even workload and the lost time at turn arounds and down time periods would not affect production.

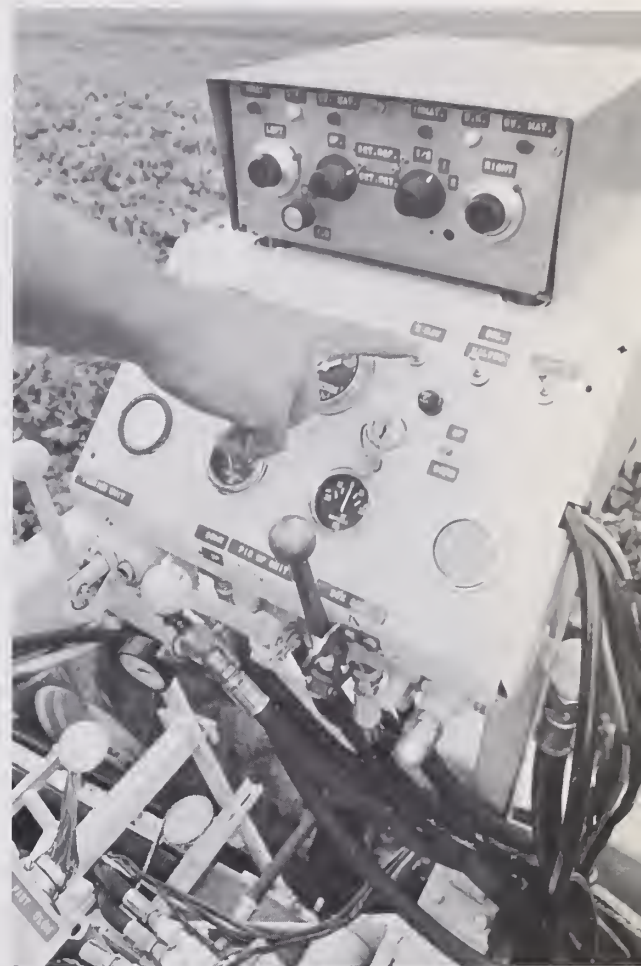
- Inspecting and tumble packing

lettuce into larger containers on the harvester—using 240-head containers rather than the present 24—head containers.

The second system would not only increase efficiency by reducing the work force, but also inflict less damage to lettuce when large heads are squeezed into the smaller cartons. Two questions need to be answered concerning the feasibility of this method of packaging and handling. One, can the product withstand the rigors of shipping from field to the terminal market? Two, will the larger containers be acceptable throughout the entire distribution system? Research on these and other problems are necessary to put mechanically harvested lettuce into tomorrow’s market baskets. □



Left: Today's lettuce harvesting involves a large, hard-working labor force—a slow and costly way to fill the Nation's salad bowls (N-44354). **Below:** Crew members—trimmers, packers, and inspectors—are at their stations as the operator lowers the selector head and starts the machine down the row. Researchers hope to further increase efficiency and reduce costs by quality inspecting and tumble packing into much larger containers on the harvester. Another cost-cutting approach under study is the use of a central location—at field edge or packing shed—to perform quality inspection and packing (0973X1443-29).



Above right: Harvester operator throws the control panel switch to activate the X-ray unit (0973X1442-31). **Left:** Agricultural engineer Paul A. Adrian checks the quality of a market-ready box of crisp head lettuce (0973X1444-4).



In hydaircooling research, scientists measure the cooling rate of peaches that have been treated with wax to curb the loss of moisture. Peach on left has been waxed, the other has not (0873X1317-8).

Cooling

RESearchers may have found a better way to cool off the warm Georgia peach and still maintain her blush.

Harvested at peak ripeness, peaches are highly susceptible to decay and loss of freshness and flavor on their way to market. Most of this loss can be prevented by precooling, which retards heat-accelerated metabolism that ripens fruit and causes loss of vital moisture and fruit sugars. However, it is also desirable to sterilize the fruit surface with fungicides and to wax it during packing to help control moisture loss and to inhibit growth of decay-producing fungi.

"Hydaircooling," a coined word which points up its difference from hydrocooling, is an experimental approach to precooling involving a mixture of chilled water and cold air. The principal cooling agent is air; the water primarily provides residual moisture and aids in refrigeration for transport. Scientists find that the process combines advantages of air cooling and hydrocooling without undesirable effects of either of the two alone.

In conventional flood type hydrocooling, the fruit is cooled in bulk bins



To insure accuracy in cooling rate comparison tests, peaches must be of uniform size. Here, Dr. Bennett measures a peach with a micrometer (0873X1317-12).



the tender peach

immediately upon arrival from the fields and kept cold until ready for packing. Then, as the peaches are taken out of cold storage and moved through the packing line, their temperature increases. Loaded onto trucks and railway cars which are not as highly refrigerated as packinghouse precoolers, peaches may stay warm for an indefinite length of time, losing much of the benefits of packing-house preparation. Many packers, therefore, rehydrocool their peaches just before loading.

Hydrocooling is ideal for rapid cooling. Cold water is circulated over the fruit at about 1,000 gallons per minute per ton of fruit in shipping containers, and 450 gallons per minute per ton of fruit in bulk bins. Unfortunately, the waxed peach retains her "cool" but loses her protective make-up. The water washes off the fungicides and waxes, leaving her exposed to decay-producing microorganisms. Air cooling does not wash or recontaminate the fruit, but it is much slower.

In the hydraircooling experiment, water was sprayed into the air at the rate of 3.5 gallons per minute per ton of fruit. (Rate of water flow was governed by the maximum amount that

can be sprayed into the air stream without washing waxes and fungicides off the fruit surface). Hydraircooling is slower than hydrocooling but faster than air cooling. Time can be saved by reducing the air temperatures to 20° F., with no harmful effects on the fruit.

Most important, hydraircooling is highly adaptable to cooling fruit that has been waxed with a fungicide for control of decay and weight loss. In experiments using a standard concentration of fungicide, peaches lost appreciably less protective wax and fungicide with hydraircooling than other methods of cooling.

Hydraircooling for peaches was developed by ARS engineer A. Herb Bennett of the Richard Russell Agricultural Research Center, Athens, Ga. and research pathologist John M. Wells of the Southeastern Fruit and Tree Nut Research Laboratory, Byron, Ga.

To more effectively test the hydraircooling concept on unit loads of fruit and vegetable products in various types of containers, a mobile experimental unit developed at Richard Russell Center is undergoing extensive commercial testing at a plant in Lake Jem, Fla. □



Research pathologist John Wells employs thermocouple to monitor the average surface and interior temperatures of peaches. Constant monitoring is necessary to evaluate the rate of heat transfer, and to avoid overchilling or freezing the fruit (0873X1317-10).

Morrison Lecture--Symbiosis of plants and people

MAN MUST FIND a new ethic, a new way to live in harmony with nature. The imbalance created by the excavation and the extraction of exhaustible natural resources must cease, contends horticulturist John P. Mahlstedte.

In short, the combined spark of society's ingenuity to use the expendable wisely and to build from enlightened experience is needed to create a "house" in which to live and a "garden" that will support man's future. These were the central views of Dr. Mahlstedte in delivering the sixth annual B. Y. Morrison Memorial Lecture. Dr. Mahlstedte is professor of horticulture and associate director of the Iowa Agriculture and Home Economics Experiment Station at Iowa State University, Ames.

In his lecture, entitled "The Symbiosis of Plants and People," Dr. Mahlstedte maintained that the interaction between man and plants is essentially a symbiotic relationship which contributes to man's sense of unity and fulfillment.

Dr. Mahlstedte said that one way man can achieve a sense of unity at a time when society, technology, and environment seem fragmented is through identification with a complete process. "The specialization inherent in so much of our society and economy seems to form a barrier preventing us from pursuing a project from its gestation to completion. In a sense, we tighten a bolt and fail to see the product until it is ready for sale in the showroom.

"The therapy of relating to the whole cycle of nature, as when we plant and nurture a seed, watch it grow and come to fruition, provides a reward and a sense of fulfillment that is difficult to evaluate economically," he explained.

Dr. Mahlstedte reviewed the long association of man and plants, dating from the recent Pleistocene epoch. In the beginning, man was primarily a gatherer. His livelihood, his very existence, in fact, was based on an understanding of the sources of plant food—where plants grew and when, which were edible, and how to store them. He hunted and later raised animals domestically, but these, too, were directly or indirectly dependent on plant life.

It has been a long and fulfilling symbiosis, this relationship between plants and man, Dr. Mahlstedte said, and now it is upon man's stewardship of the green environment that the existence of the planet, the quality of life, the oxygen he breathes depend.

Dr. Mahlstedte did not advocate setting technology aside, but rather argued for its wise implementation. He cited studies, guidelines, the paraphernalia of legal instruments that may work in concert with the growing socioeconomic awareness of the need to improve environment.

"The challenge today," he said, "is to plan for tomorrow. But only if we truly appreciate and understand the vital role of plants in our world will we be able to plan wisely for the continued productive symbiosis between people and plants."

The 1973 Morrison Memorial Lecture was delivered in New Orleans, La., before the 28th Congress of the American Horticultural Society. This lecture series is sponsored by ARS in honor of Benjamin Y. Morrison, first director of the National Arboretum. Its purpose is to recognize notable accomplishment in the environmental sciences and to stress the urgency of preserving and enhancing mankind's environment.



Dr. Mahlstedte (PN-2849).

A native of Cleveland, Ohio, Dr. Mahlstedte received his bachelor's degree in botany from Miami University, Oxford, Ohio. He was awarded a master's degree in pomology and a doctorate in ornamental horticulture by Michigan State University, East Lansing.

Dr. Mahlstedte helped develop the use of polyethylene wraps for packaging dormant nursery materials and the technique of holding dormant perennials in frozen storage. With the late Dr. E. S. Haber, Dr. Mahlstedte coauthored the textbook, *Plant Propagation*, in use at many universities. He was cited by the National Mail Order Nurserymen's Association in 1955, and again in 1971, and received the Norman J. Colman Award from the American Association of Nurserymen in 1958 for outstanding research accomplishments. □

AGRISEARCH NOTES

Mathematics vs. kochia weeds

A SIMPLE EQUATION can predict the reduction in sugarbeet root yield caused by kochia weeds, enabling a farmer to decide whether or not to remove the weeds.

Kochia weed infests more than 155,000 acres of sugarbeets in the irrigated areas of the Central High Plains and Intermountain West. While herbicides can reduce an initial kochia stand by 95 percent, some kochia remains to compete with the sugarbeets.

ARS plant physiologist Edward E. Schweizer, Ft. Collins, Colo., developed a set of equations to estimate crop losses caused by kochia, using data from specific kochia density studies. He actually derived three equations—linear, quadratic, and cubic—to cope with varying weed densities.

The linear equation works best for predicting crop loss when kochia density is 20 plants or less per 100 feet of row, which is the expected density in commercial fields after thinning. For kochia densities greater than 20 plants per 100 feet of row, cubic or quadratic equations proved superior. All three equations predict within 5 percent of the actual yield loss.

For growers, the linear equation will be useful in determining whether to employ hand labor to remove kochia remaining after thinning. Using the cur-

rent wage scale for hand labor, a farmer can compare the cost of removing the weeds with the expected loss in root yield caused by those weeds.

A test for bean blight

A TEST for detecting contaminated seed is helping restrict the spread of common and fuscous blights in navy (pea) beans.

These seed-transmitted bacterial diseases have reduced potential returns from dry edible beans as much as 7 percent annually in the principal Michigan production area.

In the test devised by plant pathologist Alfred W. Saettler, East Lansing, Mich., 1-pound samples of beans that have not been seed-treated are first surface-sterilized for 15 minutes in a 2.6 percent sodium hypochlorite solution. Samples are then rinsed in sterile water, and, after additional sterile water is added, they are incubated at room temperature for 18 to 24 hours. Liquid not taken up by the beans is then injected into the primary leaf node of 10-day-old Manitou bean seedlings. If blight bacteria are present, large, spreading lesions develop at injection points, and plants eventually die.

No evidence of blight was observed in plants grown from 200 seed lots

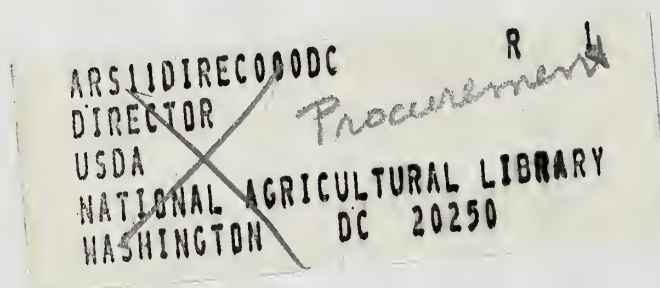
shown to be free of blight bacteria by the test. Ten seed lots shown to be contaminated by the test developed moderate to severe blight infestations when planted in the field. The test is in use in the bean seed testing program of the Michigan Department of Agriculture.

Sizing agents curb water pollution

THE ADDITION of a crosslinking resin to commercial textile sizing agents can reduce water pollution potential from textile mills by as much as 69 percent.

Sizes are applied to warp yarns to improve the weavability of the yarns which are subjected to great abrasive and tensile stresses during the weaving process. Corn starch is the most widely used sizing agent in this country, although synthetic polymers such as polyvinyl alcohol (PVA) and carboxymethylcellulose (CMC) are also used in large quantities.

Experiments on sizing agents were designed to permanently attach them by chemical means to the yarns. In this way the size would remain on the fabric during the finishing processes rather than be removed as is customary. The research was conducted by ARS textile technologist John T. Lofton and chemists Robert J. Harper, Jr., and



AGRISEARCH NOTES

Eugene J. Blanchard at the Southern Regional Research Center in New Orleans, La.

When crosslinking resins were added to the starch size formulation, finishing plant effluent contaminants dropped from a high range of 3,200 to 5,900 parts per million (ppm) down to a low range of 1,000 to 2,000 ppm, a decrease of 66 to 69 percent.

Although not quite as dramatic, reductions in pollution potential were 50 percent for both CMC and PVA. The crosslinking resin reduced contaminants from CMC from a high of 4,000 ppm to 2,000 ppm and lowered the contaminant level for PVA from 3,800 ppm to 1,900 ppm.

Keeping produce fresh

A RECENT STUDY on rhubarb, green onions, and kale provides produce shippers and market operators some practical ideas on how to keep those items at their peak of freshness until they reach consumers.

Like other crops, these vegetables start to deteriorate as soon as they are harvested. How fast they are losing their freshness can be indicated by the rate at which they give off carbon dioxide. Deterioration is proportional to respiration. Rhubarb, onions, and kale do not respire as fast as more highly

perishable foods, like asparagus, for example, but their rates are much higher than those, for, say, whole apples. Lowering the temperature markedly decreases the respiration rate. Kale at 32° F. respire about a tenth as fast as it does at 70°, rhubarb about a fourth as fast. Thus, these fresh items can be kept 4 to 6 weeks at 32° F., then remain fresh for a day or so at room temperature, and for several days if refrigerated at 50° F.

These tests, conducted by plant physiologist Howard W. Hruschka at the Agricultural Marketing Research Institute in Beltsville, Md., also showed the value of plastic wrapping in prolonging the freshness of these foods. Rhubarb stalks, for example, that went limp after 3 days when stored unwrapped at 32° F., lasted 4 weeks under these conditions in polyethylene-lined crates or in polyethylene overwraps.

For green onions, storing in controlled atmosphere (CA) of 1 percent oxygen and 5 percent carbon dioxide, or 5 percent oxygen and 15 percent carbon dioxide, prolonged freshness better than storing in air. CS-stored onions kept as long as 6 to 8 weeks at 32° F., then for another week at this temperature outside the CA chambers. After this, they were still salable for a day at 70° F.

Kale packed in the field without washing held up much better than washed kale. In 10-ounce perforated

bags, unwashed kale was salable after as long as 6 weeks' storage at 32° F. Washed kale can be stored for about half that long. After this low-temperature storage, the vegetable can still be held for sale at room temperature for a day or two.

These tests also showed that trimming before packaging these produce items not only saved up to a third in package size and shipping weight, but helped maintain fresh quality. Removing the leaf blades from stalks of rhubarb reduced total heat production, and hence the possibility of weight loss and decay. Since the leaf ends of onions are inevitably damaged in packing, their prior removal eliminates sites where decay can occur.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

